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(71) Applicant: TOUCH CONTROLS, INC. [US/US]; 520 Industrial Way, Fallbrook, CA 92028 (US).

(72) Inventors: FRULLA, Roberto, E.; 43745 Via Cielo, Temecula, CA 92593-0543 (US). KIRBY, Joseph; 4105 Beach Bluff, Carlsbad, CA 92008 (US). LUCAS, Aric; 3328 Par Drive, Oceanside, CA 93056 (US).

(74) Agent: KLEINKE, Bernard, L.; Higgs, Fletcher & Mack, LLP, Suite 2600, 401 West "A" Street, San Diego, CA 92101 (US).

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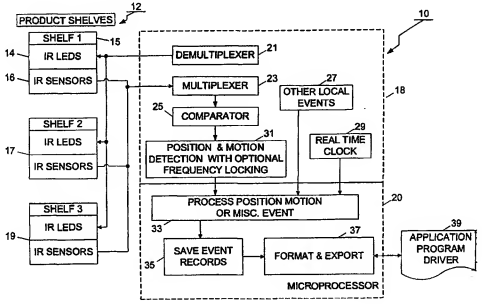

(57) Abstract

The inventive inventory control system (10) of the present invention includes a device for determining a shifting movement of the beverage containers arranged in a column or row, and another device for determining a lifting motion of the containers. Another device enables a lifting motion to be discriminated from a shifting motion to determine when a container is completely removed from its supporting surface to prevent false indications of a container removal when a partial removal occurs.

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TITLE OF THE INVENTION

PRODUCT CONTAINER INVENTORY CONTROL SYSTEM AND METHOD OF USING SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

Not Applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

REFERENCE TO A "MICROFICHE APPENDIX"

Not Applicable

BACKGROUND OF THE INVENTION

Technical Field

The present invention relates in general to an inventory control system for product containers. It more particularly relates to such a system used for product containers, such as soft drink containers stored in a refrigerated cooler in a retail store.

Background Art

Refrigerated coolers for product containers, such as bottles and cans of soft drinks, beer and the like have been employed successfully in retail stores. In this manner, a customer can remove one or more of the containers from the cooler by merely lifting the containers out of a shelf or tray which supports a column of the containers from below. The gravity feed shelf is either inclined slightly from the front to the rear to gravity feed the containers toward a front lift position.

Alternatively, other means are provided to advance the containers in the column toward the front-most lift position.

It is important to determine accurately the number of containers remaining in each shelf for re-stocking and marketing purposes. In order to provide an accurate count as to the number of containers remaining in the shelf, as well as when the products are being removed therefrom for marketing purposes, an inventory control system must discriminate between a completed removal of the container from the shelf, and a person merely partially lifting a container from a lift position, and then returning it to the shelf. A person may change his or her mind, or merely wish to examine the container before selecting it.

Therefore, it would be highly desirable to have a new and improved inventory control system which can accurately determine the number of remaining items in inventory.

Also, such a system should be capable of discriminating against other inadvertent problems which may arise, such, for example, as some of the containers becoming jammed and thus not sliding forwardly. In such a situation, the restrained containers must still be accounted for by the inventory control system. Also, it may be important to record when the containers are removed from the shelf.

Thus, it is highly desirable to have inventory control system and method which can accurately provide information regarding the number of containers remaining on a shelf at any given period of time.

SUMMARY OF THE INVENTION

Therefore, it is the principal object of the present invention to provide a new

and improved inventory control system for beverage containers.

Another object of the present invention is to provide such a new and improved inventory control system, which can accurately provide information regarding the number of containers remaining on a shelf or other supporting surface.

Yet another object of the present invention is to provide such a new and improved inventory control system, which employs an inventive apparatus and method for determining the remaining beverage container inventory each time a beverage container is withdrawn from the group of such containers.

Briefly, the above and further objects of the present invention are realized by providing a new and improved inventory control system, which employs sensors for monitoring the movement of the containers into and out of the shelf or other device for supporting the containers.

The inventive inventory control system of the present invention includes a device for determining a shifting movement of the beverage containers arranged in a column or row, and another device for determining a lifting motion of the containers. Another device enables a lifting motion to be discriminated from a shifting motion to determine when a container is completely removed from its supporting surface to prevent false indications of a container removal when a partial removal occurs.

BRIEF DESCRIPTION OF DRAWINGS

The above mentioned and other objects and features of this invention and the manner of attaining them will become apparent, and the invention itself will be best understood by reference to the following description of the embodiment of the

invention in conjunction with the accompanying drawings, wherein:

The above mentioned and other objects and features of this invention and the manner of attaining them will become apparent, and the invention itself will be best understood by reference to the following description of the embodiment of the invention in conjunction with the accompanying drawings, wherein:

FIG. 1 is a block diagram of an inventory control system made in accordance with the present invention;

FIG 2 is a diagrammatic plan view of a product shelf and sensor system for use with an inventory control system made in accordance with the present invention;

FIG 2A is a diagrammatic cross sectional view of a single product shelf of Fig. 2 taken substantially on line 2A-2A thereof;

FIG 2B is a diagrammatic cross sectional view, similar to FIG. 2A, of a single product shelf of an alternative implementation of the sensor system of Fig. 2;

FIG 2C is a diagrammatic cross sectional view of a retail cooler implementing an inventory control system made in accordance with the present invention;

FIG. 3 is a flow chart of an inventory control system of FIG. 1 in accordance with the present invention;

FIGS. 4, 5, and 6 are electronic schematic diagrams for the inventory control system of FIG. 1;

FIG. 7 is a plan view of another alternative sensor system made in accordance with the present invention;

FIG 8 is a front view of the alternative sensor system of FIG. 10;

FIG 9 is a diagrammatic plan view of an alternative product shelf and sensor system for use with an inventory control system made in accordance with the present invention;

FIG. 10 is a diagrammatic detail plan view of the mirror support strip used in the alternative product shelf and sensor system of Fig. 12;

FIG 11 is a diagrammatic detail side view of the mirror support strip used in the alternative product shelf and sensor system of Fig. 12

FIG. 12 is a diagrammatic cross sectional view of a single product shelf of for the sensor system of Fig. 12;

FIG 13 is a flowchart of a method in accordance with the present invention;

FIG 14 is a diagrammatic plan view of an another alternative product shelf and sensor system for use with an inventory control system made in accordance with the present invention;

FIG 15 is a diagrammatic side view of an another alternative product shelf and sensor system for use with an inventory control system made in accordance with the present invention;

FIG. 16a is a diagrammatic cross sectional view of another sensor system for an inventory control system constructed in accordance with the present invention;

FIG. 16b and 19c are partial diagrammatic side views of the sensor system shown in FIG. 19a; and

FIG. 17 is a flow chart of an inventory control method in accordance with the

present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring now to Fig. 1 there is shown an inventory control system 10 made in accordance with the present invention. The inventory control system 10 may operate, for example, in a retail store for assisting in the management of inventory of beverage containers. More specifically, the inventory control system 10 may be positioned on product dispensing shelves or other supporting surfaces for determining position and movement of beverage containers such as aluminum cans and plastic bottles. Typically these cans and bottles may be beverages such as soft drinks, beer, or other beverages.

The inventory control system 10 generally comprises a plurality of product shelves 12 for holding beverage containers. The product shelves 12 may have multiple product display shelves such as shelves 15,17, and 19, as well as additional shelves (not shown). Each shelf is used to display and present a row of beverage containers to customers. Each shelf has an array of infrared LEDs and oppositely positioned array of corresponding infrared phototransistor sensors for detecting beverage containers. Specifically the LEDs 14 and sensors 16 may detect events that indicate the presence or movement of beverage containers. The LED array 14 and infrared sensors 16 electrically couple to an event circuit generally indicated at 18 for validating the events sensed at the product shelves. Once validated, product shelf events are forwarded to a microprocessor generally indicated at 20. The microprocessor 20 processes the product shelf events to provide useful information concerning the inventory and consumption of beverage containers. The

microprocessor, upon request or other event, may communicate inventory management information to an external device or program driver 39.

The inventory control system 10 advantageously detects, tracks, and reports inventory information relating to the beverage containers. Using an infrared light source and sensors, the system is able to detect accurately when a beverage container is lifted from the front of the shelf, when the beverage containers shift positions on the shelf, and can accurately count the number of beverage containers remaining on the shelf. Using such information, retailers are able to better understand purchasing habits and may thus tailor their displays for optimal sales. Further, delivery of beverage containers can be scheduled when the system indicates stock is nearly depleted. Thereby, delivery companies can avoid costly excess deliveries when stock is not required, and retail outlets can receive product before all the beverage containers are sold.

In operation, the inventory control system 10 has arrays of LEDs and sensors positioned adjacent beverage containers on product shelves. The LED and sensor arrays are used to detect the presence or movement of beverage containers on the product shelves. The event circuit 18 and the microprocessor 20 accept the information from the LEDs and sensors to determine a present inventory of beverage containers on the product shelves.

Each time a customer takes a beverage container from a product shelf, the movement and removal of the beverage container is detected and recorded by the inventory control system 10. In a similar manner, each time a stocking clerk places a

beverage container on the product shelf, such addition is detected by the LED and sensor arrays. The processor thereby appropriately updates the inventory of beverage containers in response to detected beverage events. Further, in the situation where a customer first removes a beverage container, then changes their mind and returns the beverage container to the shelves, the inventory control system 10 detects such activity and appropriately makes no adjustment to the beverage inventory.

Considering now the inventory control management system 10 in more detail. With reference to Figs. 1 and 2, the product shelves 12 included individual product shelves 15,17, and 19. Each of the individual product shelves 15, 17, 19 are configured for holding a plurality of beverage containers such as a container 50. Those skilled in the art will recognize more or fewer shelves may be used. Referring to Fig. 2c, the product shelves 12 are generally positioned on a display rack 55, possibly within a beverage cooler 51, with selection end 46 positioned in a manner so that a customer may conveniently remove a beverage container such as a container 50 from any of the individual shelves 15, 17 or 19.

To access the product shelves 12 such as the shelve 15, a customer opens a door 53 of a cooler 51 and then physically removes a beverage container 59. Only when the door is open will a customer be able to reach the beverage container 59. The product shelve 15 also has a rear stocking end 48 which may be accessed by a stocking clerk from within the cooler for placing beverage containers on to the product shelves.

The rear stocking end 48 of the product shelf may be elevated vertically relative to a front selection or lift end 46 as indicated in Fig. 2c. In such a manner, as a beverage container 50 is removed from the selection end 46, other beverage containers in that row will shift or slide forwards under the force of gravity toward the selection end, thereby filling the void left by the removed beverage container. Thus, as each beverage container is removed by a customer, gravity causes the remaining beverage containers on that product shelf to move or shift toward the selection end 46. In a similar manner, if a stocking clerk places a beverage container onto a product shelf from the rear stocking end 48, the beverage container shifts due to gravity from the stocking end 48 towards the selection end 46. The beverage container shifts toward the selection end 46 until the beverage container either reaches the selection end 46 or contacts beverage containers already on that shelf.

Turning now to describe individual product shelves in more detail. The product shelf 12 may contain several individual product shelves such as individual product shelf 15, 17 or 19. Since the individual product shelves are similar, only individual product shelf 15 will be described in detail. Individual product the shelf 15 has a selection end 46 and a stocking end 48. Shelf walls 44 provide opposite boundaries for holding beverage containers 50. The distance between shelf walls 44 are dimensioned to accommodate different sizes of beverage containers. For example, some juice containers are narrow in diameter, while other liquids such as soft drink and water containers may be sold in larger diameter beverage containers.

One of the shelf walls 44 has an LED array 40 for providing a light source,

such as an infrared output. The infrared array 14 comprises individual LEDs 40 which are spaced such that when beverage containers are placed on the product shelf 15, each positioned beverage container blocks only one LED 40. Sensor array 16 is positioned oppositely the LED array 14 so that each LED is positioned oppositely and spaced apart from a sensor and in a manner so the light path between the LED and its corresponding sensor traverses a product space or position.

The sensor array 16 comprises individual photo electric sensors 42 in the form of individual photo transistors, each of which is positioned oppositely an associated individual LED 40. Each sensor on an individual product shelf is thereby vertically and horizontally offset or separated from the next sensor. In such a manner the sensor 42 is able to detect infrared light emanating from an associated and oppositely positioned LED 40 and provide useful information with regard to product lifting and shifting movements.

Each beverage container positioned on the product shelf 15 assumes a product position, such as product positions 56, 57, and 58. For example, a first or lowermost beverage container 59 assumes product position 56, which is the product lift position for a customer to gain access to this container resting therein. A second beverage container 54 resting on the product shelf 15 at the product position shifts or slides forwardly under the force of gravity to the lift position 56 when the container 59 is removed from the shelf. Thereby, product positions 58 and other rearwardly disposed product positions do not contain beverage containers, as illustrated in the drawings.

For each product position such as positions 56, 57 and 58, an LED is positioned oppositely a sensor. If a beverage container is positioned in a product space, the beverage container blocks the light emanating from one of the LEDs. In such a manner the sensor associated with the blocked LED is blocked from receiving the infrared light from the LED source, such as in product positions 56 and 57. However, for product positions not having a beverage container disposed therein, such as product position 58, the oppositely opposed LED and sensor is separated by an unobstructed light path. Thereby in the vacant product positions, the sensor detects the infrared light emanating from the oppositely positioned LED source.

Referring now to Fig. 2A, shelf walls 44 are shown with the LED 40 and the sensor 42 positioned near a base 47 of the product shelf 15. In this manner, an existing shelf can be retrofitted with the system 10. As indicated, infrared light emanates from the LED 40 and is received at the sensor 42. Fig. 2A shows a product position without a beverage container so that the light emanating from the LED is not blocked and is therefore received by the sensor 42.

In mounting the LED's and sensors, those skilled in the art will recognize that the LED and sensors may be individually placed adjacent to shelf walls. Alternatively multiple LEDs may be positioned on a support member such as a strip of plastic material and the entire support member then positioned on the product shelf. In a similar manner, sensors may be positioned on a sensor support member so that the sensor support member can be positioned on an opposite wall of the product shelf. In such a manner, an entire array of LEDs and an entire array of

sensors may be positioned on a product shelf by positioning the supporting members. Thereby existing product shelves may be retrofitted to accommodate the contemplated inventory management system 10.

Although the LED 40 and the sensor 42 are shown positioned at the base 47 of product shelf 15, other methods to attach LEDs and sensors will be recognized by those skilled in the art. For example, Fig. 2B shows an alternative construction where a pair of shelf walls 45 having an LED 41 built into one shelf wall and a sensor 43 built into the oppositely positioned shelf wall. Such a configuration may be used when the product shelves are initially designed and manufactured for use with the inventory management control system 10 incorporated therein.

Referring now to Fig. 1, the product shelves 12 are shown with individual product shelves 15, 17, and 19. Each shelf has an infrared LED array 14 and an oppositely positioned infrared sensor array 16. The infrared LEDs on array 14 may be activated through a demultiplexer 21. Thereby only a selected infrared LED may be activated at a particular time. In a similar manner, events detected by the infrared sensors may be directed through multiplexer 23. In such a manner the event circuit 18 can selectively activate LED's and monitor sensors to increase the likelihood that a detected sensor event is valid. Thus, since the event circuit 18 and the microprocessor 20 can drive individual infrared LEDs through the demultiplexer 21 and further can sense individual infrared sensors through multiplexer 23, the event circuit 18 can ignore sensing signals detected that were not generated in response to the activated infrared LED.

The sensors of sensor array 16 are normally non-conductive but become conductive responsive to sensing infrared light. The level of conductivity is related to the level of infrared light received. Therefore, when infrared light is received at the sensor, current flow is related to the intensity of the infrared light. Those skilled in the art will recognize that the level of current flow is readily transformed to a corresponding change in voltage.

Since the product shelves 12 may be positioned in an area having a high content of ambient infrared light, the sensor may become conductive even when its associated LED is not illuminated or blocked by a container. In such a manner, the sensor generates a false event. Preferably, the system 10 detects and ignores such false events. For this purpose, a comparator 25 that sets a threshold which must be exceeded for the system to recognize that a sensor has been activated by an LED. Further, since infrared light may be present from other sources such as ambient or product lightings, an additional circuit 31 is used to further eliminate false event indications through a method of frequency matching.

The inventory control system 10 may also respond to other events circuit 27. For example, a sensor may be placed on the door 53 (FIG. 2C) to the cooler 51. Thereby the system 10 can detect when a customer has opened the cooler door 53. In such a manner, if sensor activity is detected with the door closed, then the system detects that the activity cannot be generated by a customer moving beverage containers from the front end of the product shelf. Further, the event circuit includes a real-time clock 29 for accepting time information. Thereby event duration may be

calculated. For example, the length of time a door is held open can be calculated. Also, the real-time clock 29 can be used to time-stamp events or other activities. In such a manner the inventory control system 10 may determine use information for the beverages on a shelf for particular times and periods for marketing and re-stocking purposes.

Information from the event circuitry 18 is directed into a microprocessor 20. Those skilled in the art will recognize that some of the functionality of the event circuitry 18 may be incorporated or operate under the control of the microprocessor 20.

The microprocessor 20 records and saves detected events at 35 and formats and exports information at 37. The microprocessor 20 may export information upon command from, for example an external application program 39 or may do so automatically based on an event from the real-time clock 29. The microprocessor 20 may cause information on beverage container activity and usage to be forwarded to a centralized location (not shown) for further processing or may cause the information to be displayed or used locally. Those skilled in the art will recognize the microprocessor may export information in a variety of manners including computer networks, wireless communication, or hard wired configurations.

Referring now to Fig. 3, there is shown a flow chart of a method made in accordance with the present invention. Specifically the flow chart describes a method which may be used to operate the inventory management control system 10. In referring to the flow chart the "first sensor" refers to the sensor positioned near

the selection end of the product shelf at the forward lift position 56. The "last blocked sensor" refers to the sensor closest to the stocking end that is blocked. For example, in Fig. 2, the product lift position 56 is associated with the first sensor and product position 57 is associated with the last blocked sensor. By sensing the first and last blocked sensors, the system can readily calculate how many product positions have beverage containers. Thereby accurate shelf inventory may be determined.

The method of Fig. 3 operates on each individual product shelf, or column, sequentially. To detect accurately product changes, each product shelf must be scanned for changes at a sufficiently fast rate. For example, it has been found that scanning the sensors of a product shelf every 15mS provides an adequate indication of product activity. Those skilled in the art will recognize that other rates may be selected in accordance with the present invention.

In block 60 the method asks if any sensor has changed state from the previous scan. A change for a sensor is detected if a blocked sensor becomes unblocked or an unblocked sensor becomes blocked. Such a change will occur when a beverage container is lifted, shifted, or added to a product shelf. If no sensors have changed, then the system proceeds to interrogate the next sequential product shelf.

If any sensor has changed, then in block 61 the previous state for the first sensor and the previous state for the last blocked sensor is retrieved. If both the first blocked sensor and last blocked sensor are the same as in previous scan, then there has been a false indication of a sensor change and the system proceeds to scan the

next column or shelf as shown in blocked 62.

However, if a change has been detected in blocked 62, then the system proceeds to ask if the first sensor is blocked in block 63. If the first sensor is blocked, then the system knows that the change in sensor activity was not caused by a customer removing a beverage container from the first product position. Such an event may occur if the stocking clerk places an additional beverage on the shelf. If the first sensor is not blocked in the present scan, then the system detects that an activity is taking place with the first beverage container in the product shelf.

As determined thus far in the flow chart, the first sensor is not blocked. This indicates that a beverage container has been shifted or lifted from the first product position. As this occurs the last blocked sensor should stay blocked as indicated in block 64. After waiting for a period of time in block 65, the first sensor will once again become blocked. The first sensor will become blocked either because the customer replaced the beverage container, or the remaining beverage containers on the shelf shifted to fill the void left by the removed beverage container.

After the first sensor is blocked, the system then considers the last blocked sensor in block 66 to determine if the last blocked sensor is still blocked. If the last blocked sensor is still blocked, then block 67 indicates that a beverage container was inserted and existing containers were pushed back. Therefore, the system adds 1 to the inventory. However if the last blocked sensor is now unblocked, then block 68 indicates that a beverage container was removed from the product shelf and 1 is subtracted from the beverage inventory.

The system then compares the calculated inventory count with the total number of blocked sensors in block 69. If the count is consistent, then the system is updated in blocked 72 and the system moves to the next column or shelf in block 73. However, if the count is not consistent, then the system proceeds to address the detected event as a "special case" in block 71. The special case may be handled, for example, by generating an alarm to cause a human intervention. Alternatively the system may acknowledge and log the event. Further, the system may automatically contact a third party to intervene and possibly repair the product display shelving.

Considering now the circuit 18 in greater detail with reference to FIGS. 4, 5 and 6, a set of channel selection lines 81 (FIG. 4) include selection lines 82, 83, 84 and 85. The channel selection lines 81 electrically connect to a multiplexer/demultiplexer device 86. The multiplexer/demultiplexer device 86 is shown as a 1 of 8 device, but those skilled in the art will recognize more or fewer channels may be used depending on system requirements. The channel selection lines are driven from the microprocessor 20 for selecting which infrared LED will be activated sequentially. Although the system activates LEDs and sensors sequentially, those skilled in the art will recognize other selection methods may be substituted.

By placing a binary input on channel selection lines 81, one of the channels 94 may be selected. Each of the channels 94 activates an LED/Sensor pair. For example, by placing a binary 0 on the channel selection lines 81, channel 95 is selected. If 3 selection lines are used, then 1 of 8 channels can be selected. By

increasing the number of selection lines, additional channels may be selected.

Only when channel 95 is selected by the demultiplexer/multiplexer 86 will sensor 42 be able to generate a signal on the sensor line 89. Therefore, with channel 95 selected, LED 40 transmits infrared light toward the sensor 42. If the path between the LED 40 and a sensor 42 is not blocked, the sensor 42 causes an event signal on sensor line 89. As those skilled in the art will recognize, ambient infrared light may also cause a signal on the sensor line 89.

Sensor line 89 is accepted into the comparator 101 as shown in Fig. 5. The comparator 101 is provided a reference voltage to be compared to the signal level which is on signal line 89. In such a manner the signal content on signal line 89 caused by the presence of ambient light can be removed. Thereby a comparator signal 105 is more likely to indicate that infrared light from the sensor caused an event and reduce the occurrence of false events.

To further eliminate false events, the signal 105 may be accepted into a frequency discriminator 109. The frequency discriminator 109 produces a frequency line output 87 which is accepted into the op amp array 91 for driving the LED array 14. For example, the frequency comparator 109 may produce pulses operating at rate of 10,000 Hz. In such a manner operational amplifier 92, which drives LED 40, would produce pulses of light at the rate of 10,000 Hz.

The frequency comparator 109 also accepts the comparator out signal 105, which carries events detected at the sensor that exceed a reference threshold. For the events on the comparator out signal 105 to indicate a valid event, the event on the

compared out signal 105 should have a close correlation to the pulses generated on the frequency line 87. For example, it has been found that if the frequency of the event on the comparator out signal 105 is within approximately 12% of the pulse frequency on line 87, then the event on comparator out signal line 105 is a valid event.

Once a valid event has been detected, the event is forwarded to the microprocessor on processor signal 110. Since the microprocessor directs which sensor is active, the microprocessor can determine sequentially which sensors are blocked and which are receiving light from their associated LED. In such a manner the microprocessor can determine when a beverage container is lifted, shifted, or added. Further, the microprocessor may provide information to compare expected inventory levels to the actual inventory on the product shelf.

Referring now to Figs. 9, 10, 11, and 12, another sensor system 178 is shown made in accordance with the present invention. The sensor system 178 has a product shelf 170, similar to product shelves already described. The product shelf 170 has a plurality of product spaces such as product space 175 and product space 176. Positioned on one shelf wall is an array of mirrors 179. This array of mirrors may be individually mounted to the shelf wall 180 or may be applied to a supporting member as already described. In such a manner, the supporting member with the mirror array may be attached to a shelf wall 180.

The mirror array 179 has a plurality of mirrors which direct light from a sensor/LED 171, across the product spaces, to a reflective surface 174. If the

product space is empty then the infrared light is reflected back to the mirror and then back to be sensor/LED 171. The mirrors on the mirror array 179 are arranged with graduated heights such that the mirrors closer to be sensor\LED are shorter, and the longer or taller mirrors are at the selection end of the shelf. Thereby, when the sensor\LED directs its light down the mirror array, mirrors further from the light source are not completely in the shadow of a previous mirror. In a similar manner, reflected light may be received at the sensor/LED from all the mirrors.

For each product space that holds a beverage container, little to no light is returned to the sensor/LED. Therefore, the more beverage containers on the shelf, the less total light is reflected back to the sensor LED 171. Thereby, a scaled relationship exists between the level of light received at the sensor/LED and the number of beverage containers on the product shelf. The sensor/LED is configured to produce a voltage output related to the level of light received. Therefore, the voltage output from the sensor/LED will have a scaled relationship to the number of beverage containers on the shelf. The method of determining the number of beverage containers is further shown in Fig. 16.

Fig. 13 shows that in block 190 a voltage is applied to the LED and light directed down the mirror array 179. Light is reflected back to sensor/LED at a level scaled to the number of beverage containers interfering with the light beam. The reflected light is received back at the sensor/LED and creates a voltage. In block 191 the voltage induced at the sensor/LED 171 is determined. Block 192 then asks if the voltage has changed from the previous reading. If a change has occurred, block 193

then multiplies the voltage by a scaling constant. The scaling constant reflects the relationship between the level of light returned and the number of beverage containers blocking the light beam. The scaling factor may be linear or may be developed through experience. Block 194 then converts the resulting factor to an inventory number. With the number of beverage containers now known for the scanned shelf, the system proceeds to the next product shelf as indicated in block 195.

Fig. 14 shows another sensor system 206 for use with the inventory control system of the present invention. The system 206 operates on a product shelf 200. A transmit mirror array 201 directs light generated from the LED 205 across the product spaces of the product shelf 200. The mirrors are graduated in height in an arrangement as discussed above where the mirrors nearer the LED are shorter and the mirrors further from the LED are longer. Thereby the mirrors direct a beam of light through every product space.

A sensor mirror array 202 on the opposite wall of the product shelf receives the light beams and directs the light to a single sensor 204. As described above, the mirrors on mirror array 202 are shortest near the sensor and are longest further from the sensor. Thereby, as the number of beverage containers in the product shelf is increased, the level of light received at sensor 204 will be reduced. By applying the methodology of Fig. 16, an inventory count may be determined.

Fig. 15 shows another sensor system 210 for an inventory control system. In this sensor system, however, sensors and LEDs are positioned above the product

spaces, such as a product space 211. In such a manner, LED 212 directs a light beam toward product space 211. A reflective surface 212 reflects infrared light to sensor 213 if no beverage container is in the product space 211. If, however, a beverage container is in the product position 211, then light emitted from the LED is not received at the sensor. In such a manner the presence of a beverage container is determined for every product space on the shelf.

Figs. 16A, 16B, and 16C present another sensor system 225 for use with an inventory control system of the present invention. The sensor system 225 is positioned at the selection end of a product shelf 232. Two transmitters, 227 and 229, are positioned on a sidewall 226 of the product shelf 232. On the opposite sidewall 231 of the product shelf 232, sensors 228 and 230 are positioned. LED 227 is positioned opposite sensor 228, while LED 229 is positioned opposite sensor 230. Thereby, the LED/sensor pairs are positioned in product position 1 of the product tray 232.

As shown in Fig. 16B, LED 227 is positioned above LED 229 by a distance indicated by dimension A 233. Further, LED 227 is positioned rearwardly of LED 229 by a distance indicated by dimension B 235. In this regard, forward is toward the selection end of the product tray 232. Dimension A 233 and dimension B 235 are selected such that the light beams emanating from LEDs 227 and 229 will both be blocked if a beverage container is positioned at the front of the product tray 232 in what has been called product position 1. Sensors 228 and 230 have a similar dimensional relationship.

When the product tray 232 has one or more beverage containers stocked, a beverage container will be positioned in product position 1, thereby blocking light beams 240 and 241 from reaching sensors 228 and 230. If the beverage container in product position 1 is lifted from of the product shelf, the bottom light beam 241 becomes unblocked with sensor 230 sensing the light beam 241 emanating from LED 229. As the beverage container continues to be lifted, the upper light beam 240 is cleared, with sensor 228 now receiving the light bean 240 from LED 227. The inventory management system registers that a beverage container has been lifted from the product shelf and inventory count is decremented.

Similarly, if the beverage container is inserted from the front of the product shelf, both light beams 240 and 241 are first in an unblocked state. As the beverage container is dropped into the product position 1, the top light beam 240 is blocked first with the lower light beam 241 blocked second. In such a manner, the inventory control system understands that a product has been added to the front of the product shelves and the inventory count is incremented by one. This method is further described in the flowchart of Fig. 17.

Fig. 17 shows a flow diagram of a method implementing a two-sensor inventory management system. The flow diagram has two related routines, the first indicated as Routine 1 260 and the second as Routine 2 274. Routine 1 260 starts in block 261 by acknowledging both sensors are blocked. This status is checked in blocks 262 and 263, where both the bottom and top sensors are checked. As indicated in block 263, if the top sensor somehow becomes unblocked while the

bottom sensor is still blocked, then an error condition occurs, as indicated in block 273. However, if the bottom sensor becomes unblocked, then block 264 interrogates the status of the top sensor. If the top sensor is not blocked, then the system knows that the beverage container previously at the front of the product shelf is being pushed back and not lifted out. Therefore, block 265 indicates that a pushback is occurring and the system jumps to Routine 2 274. If the top sensor is blocked, then the system knows that a beverage container is being lifted, as shown in block 266.

If at the next change both sensors are not blocked, then block 267 indicates that a product has been removed, as shown in block 268. The system then continues with Routine 274. However, if both sensors are not blocked on the next change, then block 269 interrogates whether both sensors are blocked. If both sensors are blocked, then block 270 indicates that the product was returned after a partial lift. The system then restarts Routine 1 260. If both sensors are not blocked, then 271 asks if the bottom sensor is blocked and the top sensor is not blocked. If so, then an error condition has occurred, as indicated in block 273. If the bottom sensor is still blocked but the top is not blocked, then block 272 directs the process back to 266 until the system times out. If a time out occurs, then an error condition is indicated.

Function 274 is used when both sensors are not blocked, as indicated in block 275. If the system times out in block 276, then the system understands the product tray is empty, as shown in block 277. If the top sensor is not blocked, then the sensors are interrogated in block 278 until either the top sensor becomes blocked or a time out occurs. Once the top sensor is blocked, then block 279 asks if the

bottom sensor is still not blocked. If the bottom sensor is blocked, then in block 280, the system knows a beverage container has slid forward and the system continues with Function 1 260. If the bottom sensor is still unblocked, then block 281 understands that a product replacement is occurring. If both sensors become blocked in block 282, then a product has been replaced and the inventory is incremented by one, as shown in 287. The system then returns to Function 1. However, if both sensors do not become blocked, as indicated in block 283, then replacement was aborted in block 286 and the system returns to start Function 2 274. If the bottom sensor is blocked but the top sensor is not blocked, then there must be an error condition, as a replacement condition could not be occurring. However, if the top sensor is blocked and the bottom sensor is not blocked and time has not run out on the timer of block 285, then another interrogation will be made, as indicated in block 281.

Although the inventory control systems and sensor systems described thus far have been primarily for use in a retail cooler shelf configuration, the invention may be advantageously used in many other product environments for any type of packaged product.

Further, the inventory control system may be used in any environment where containers or products are accumulated in an orderly fashion. Many different types and kinds of products may be monitored, including, but not limited to, non-food products such as motor oil containers, clothing products, and a variety of other items. Another example may be a system used to monitor the quantity and flow of

containers as they are being filled at a manufacturing station.

While particular embodiments of the present invention have been disclosed, it is to be understood that various different modifications are possible and are contemplated within the true spirit and scope of the appended claims. There is no intention, therefore, of limitations to the exact abstract or disclosure herein presented.

CLAIMS

What is claimed is:

1. An inventory control system for a group of products disposed in an aligned order, comprising:

means for determining the position of at least one product;

means for determining a shifting movement of at least one of the products; and

means for determining a lifting movement of at least one of the products.

2. A system according to Claim 1, wherein said means for determining the position of a product includes at least one light emitting device and a light sensor for generating signals when the product is removed from blocking engagement in the light path between the device and the sensor.

3. A system according to Claim 2, wherein said means for determining the lifting movement of a product includes computer means being responsive to said device and said sensor.

4. A system according to Claim 3, wherein said means for determining a shifting movement of at least one of the products includes another one of said sensors for helping determine the shifting movement of the containers, and means for mounting said another sensor in an offset manner both vertically and horizontally relative to the first-mentioned sensor.

5. An inventory control system for a group of products disposed in an

aligned order, comprising:

means for sensing the lifting of at least one of the products from the group; and

means for determining the remaining number of products in the group after said at least one of said products is lifted therefrom.

6. An inventory control system according to Claim 5, wherein said means for determining the remaining number of products includes means for sensing the shifting movement of the rear most product in the group.

7. An inventory control system according to claim 5, wherein said means for sensing includes a light emitting device and a light sensitive device.

8. An inventory control system according to claim 7, further including reflective surface for controlling the light path between said light emitting device and said light sensitive device.

9. An inventory control system according to claim 7, further including a pair of light sensitive devices mounted near a light emitting device, a reflective surface being mounted spaced apart and oppositely disposed relative to the last mentioned devices.

10. An inventory control method for a group of products disposed in an aligned order, comprising:

determining the position of at least one product;

determining a shifting movement of at least one of the products; and

determining a lifting movement of at least one of the products.

11. A method according to Claim 10, wherein said determining the position of a product includes providing at least one light emitting device and a light sensor for generating signals when the product is removed from blocking engagement in the light path between the device and the sensor.

12. A method according to Claim 11, wherein said for determining the lifting movement of a product includes responding to said device and said sensor.

13. A method according to Claim 12, wherein said determining a shifting movement of at least one of the products includes providing another one of said sensors for helping determine the shifting movement of the containers, and mounting said another sensor in an offset manner both vertically and horizontally relative to the first-mentioned sensor.

14. A method according to claim 10, further including sensing the removal of at least one of the products from the group; and

determining the remaining number of products in the group after said at least one of said products is lifted therefrom.

15. A method according to Claim 14, wherein said determining the remaining number of products includes sensing the shifting movement of the rear most product in the group.

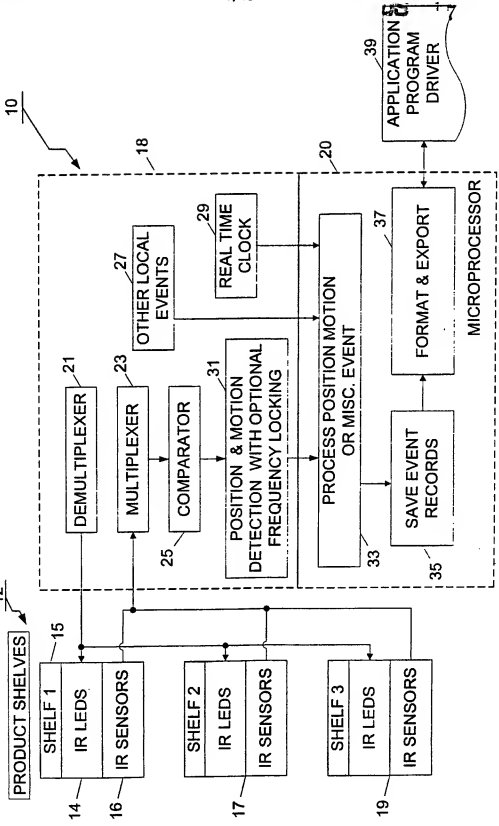
10
12
PRODUCT SHELVES
SHELF 1
IR LEDS
IR SENSORS
SHELF 2
IR LEDS
IR SENSORS
SHELF 3
IR LEDS
IR SENSORS
14
15
16
17
19
18
20
DEMULTIPLEXER
MULTIPLEXER
COMPARATOR
POSITION & MOTION DETECTION WITH OPTIONAL FREQUENCY LOCKING
OTHER LOCAL EVENTS
REAL TIME CLOCK
PROCESS POSITION MOTION OR MISC. EVENT
SAVE EVENT RECORDS
FORMAT & EXPORT
MICROPROCESSOR
21
23
25
27
29
31
33
35
37
APPLICATION PROGRAM DRIVER
39

FIGURE 1

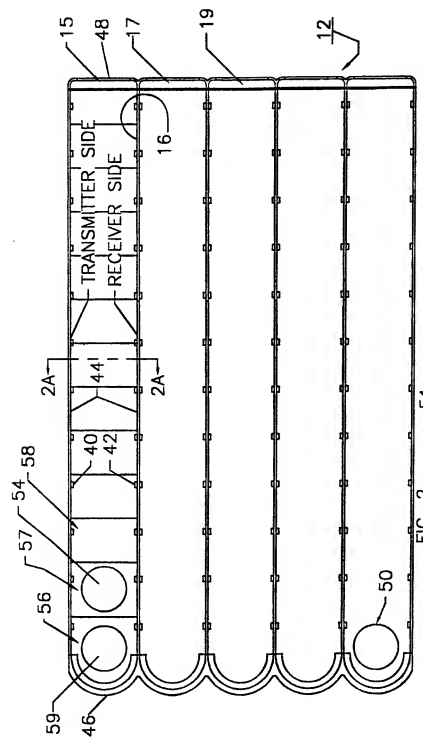

FIG. 2

FIG. 2B

FIG. 2C

FIG. 2A

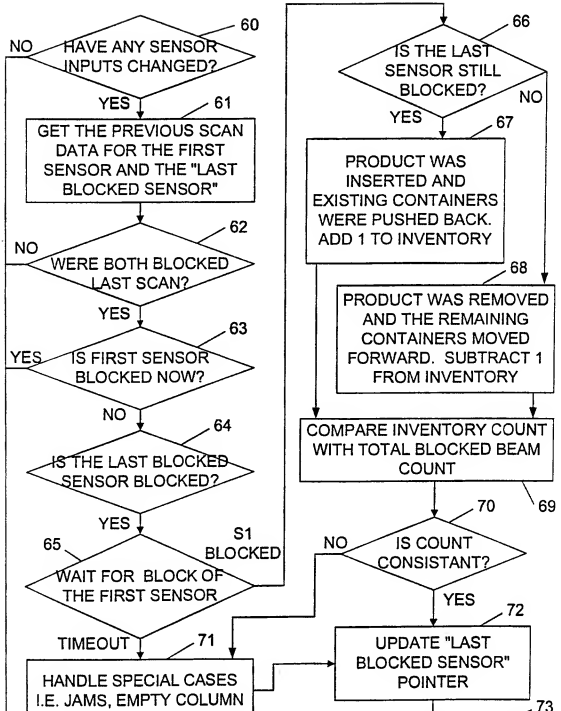
60
HAVE ANY SENSOR INPUTS CHANGED?
NO
YES
61
GET THE PREVIOUS SCAN DATA FOR THE FIRST SENSOR AND THE "LAST BLOCKED SENSOR"
62
WERE BOTH BLOCKED LAST SCAN?
NO
YES
63
IS FIRST SENSOR BLOCKED NOW?
YES
NO
64
IS THE LAST BLOCKED SENSOR BLOCKED?
YES
65
WAIT FOR BLOCK OF THE FIRST SENSOR
S1 BLOCKED
TIMEOUT
71
HANDLE SPECIAL CASES I.E. JAMS, EMPTY COLUMN
66
IS THE LAST SENSOR STILL BLOCKED?
YES
NO
67
PRODUCT WAS INSERTED AND EXISTING CONTAINERS WERE PUSHED BACK. ADD 1 TO INVENTORY
68
PRODUCT WAS REMOVED AND THE REMAINING CONTAINERS MOVED FORWARD. SUBTRACT 1 FROM INVENTORY
COMPARE INVENTORY COUNT WITH TOTAL BLOCKED BEAM COUNT
69
70
IS COUNT CONSISTANT?
NO
YES
72
UPDATE "LAST BLOCKED SENSOR" POINTER
73
DO THE NEXT COLUMN

FIGURE 3

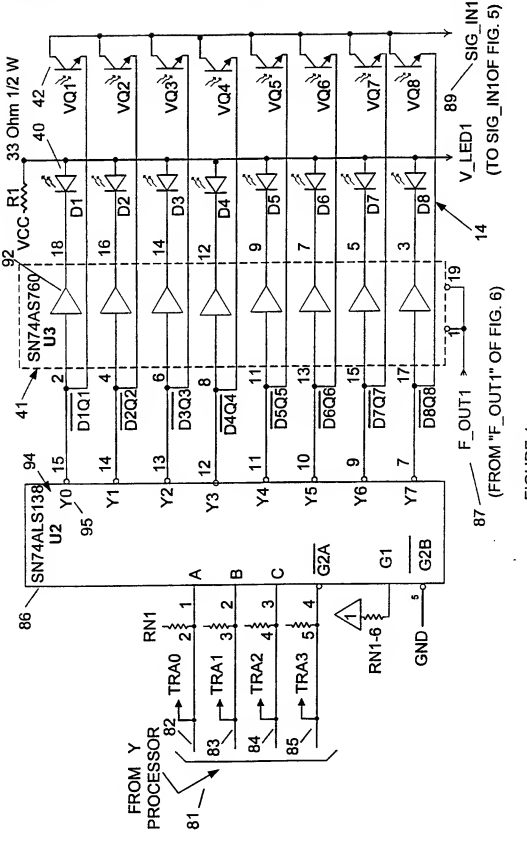
FROM Y PROCESSOR
81
82
83
84
85
TRA0
TRA1
TRA2
TRA3
RN1
RN1-6
GND
A
B
C
G2A
G1
G2B
SN74ALS138
U2
86
94
95
Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
41
SN74AS760
U3
92
VCC
R1
33 Ohm 1/2 W
40
D1Q1
D2Q2
D3Q3
D4Q4
D5Q5
D6Q6
D7Q7
D8Q8
D1
D2
D3
D4
D5
D6
D7
D8
VQ1
VQ2
VQ3
VQ4
VQ5
VQ6
VQ7
VQ8
42
F_OUT1
87
(FROM "F_OUT1" OF FIG. 6)
V_LED1
14
SIG_IN1
89
(TO SIG_IN1OF FIG. 5)

FIGURE 4

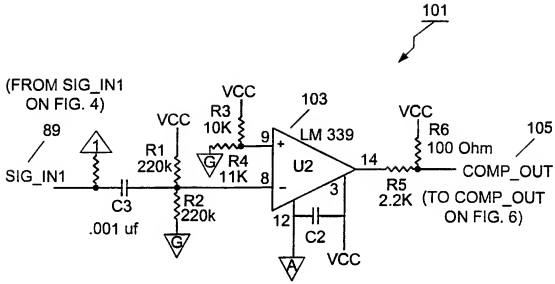

FIGURE 5

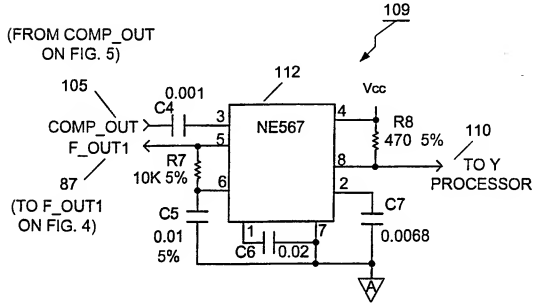

FIGURE 6

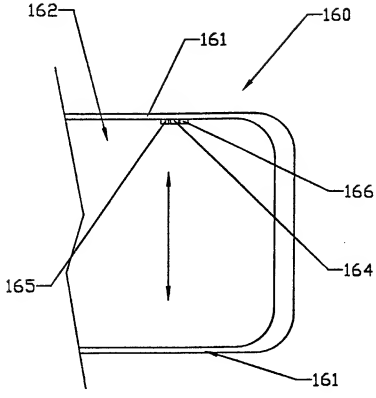

FIG. 7

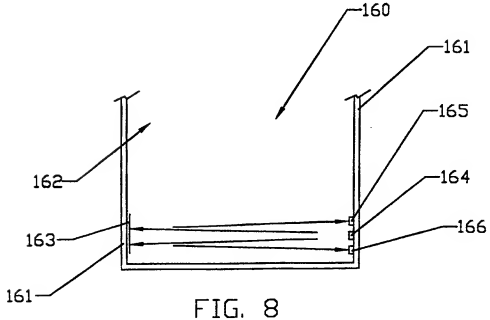

FIG. 8

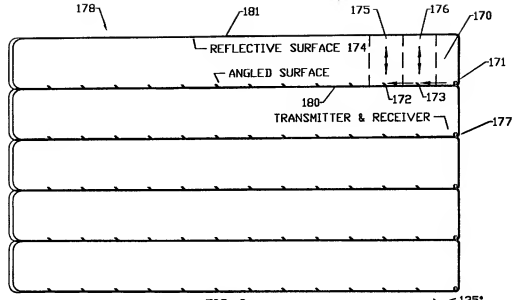

FIG. 9

FIG. 10

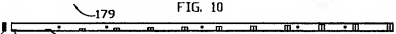

FIG. 11

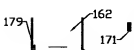

FIG. 12

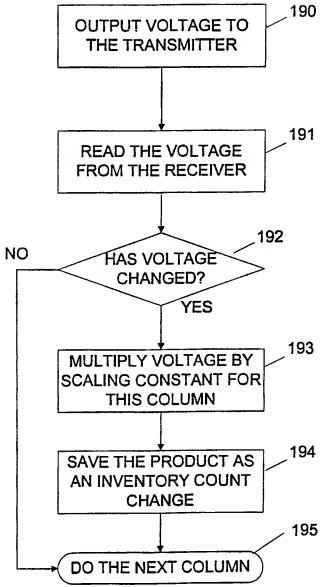
OUTPUT VOLTAGE TO THE TRANSMITTER
190
READ THE VOLTAGE FROM THE RECEIVER
191
HAS VOLTAGE CHANGED?
192
NO
YES
MULTIPLY VOLTAGE BY SCALING CONSTANT FOR THIS COLUMN
193
SAVE THE PRODUCT AS AN INVENTORY COUNT CHANGE
194
DO THE NEXT COLUMN
195

FIGURE 13

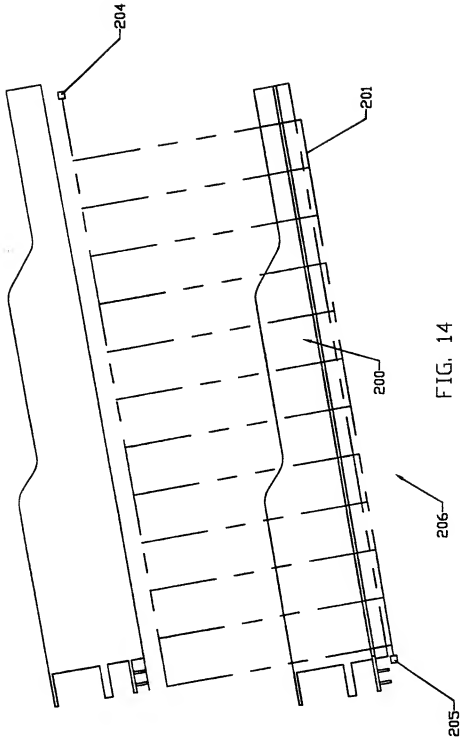

FIG. 14

SUBSTITUTE SHEET (RULE 26)

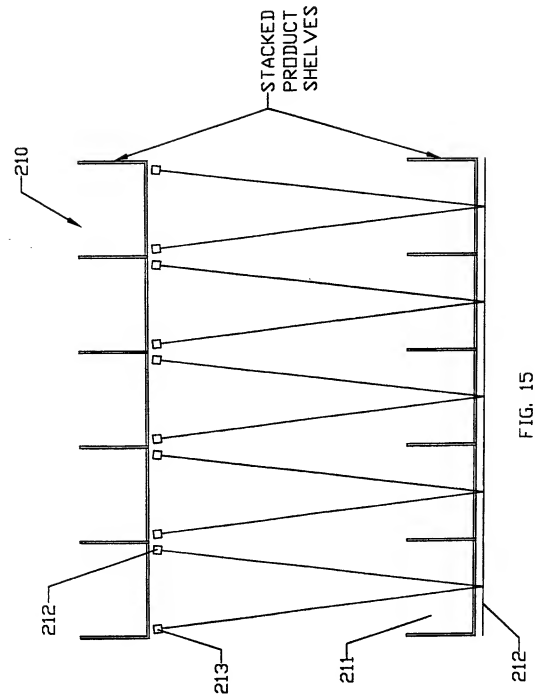

FIG. 15

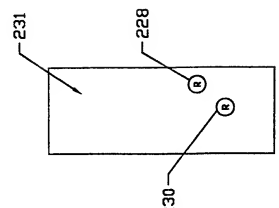

FIG. 16c

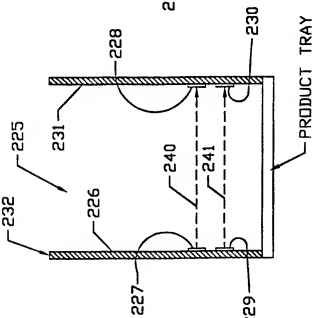

FIG. 16a

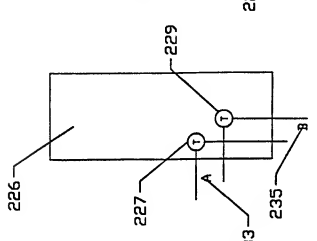

FIG. 16b

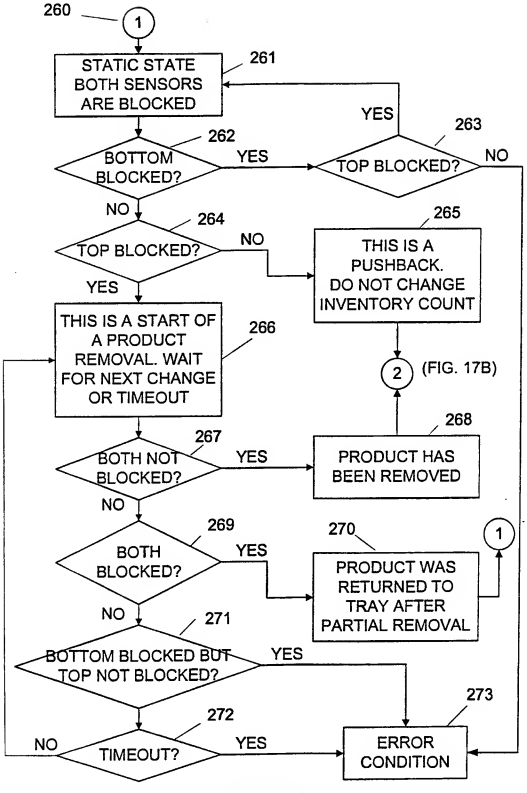
260
1
STATIC STATE BOTH SENSORS ARE BLOCKED
261
BOTTOM BLOCKED?
262
YES
TOP BLOCKED?
263
YES
NO
NO
TOP BLOCKED?
264
NO
THIS IS A PUSHBACK. DO NOT CHANGE INVENTORY COUNT
265
YES
THIS IS A START OF A PRODUCT REMOVAL. WAIT FOR NEXT CHANGE OR TIMEOUT
266
2
(FIG. 17B)
BOTH NOT BLOCKED?
267
YES
PRODUCT HAS BEEN REMOVED
268
NO
BOTH BLOCKED?
269
YES
PRODUCT WAS RETURNED TO TRAY AFTER PARTIAL REMOVAL
270
1
NO
BOTTOM BLOCKED BUT TOP NOT BLOCKED?
271
YES
TIMEOUT?
272
NO
YES
ERROR CONDITION
273

FIGURE 17A

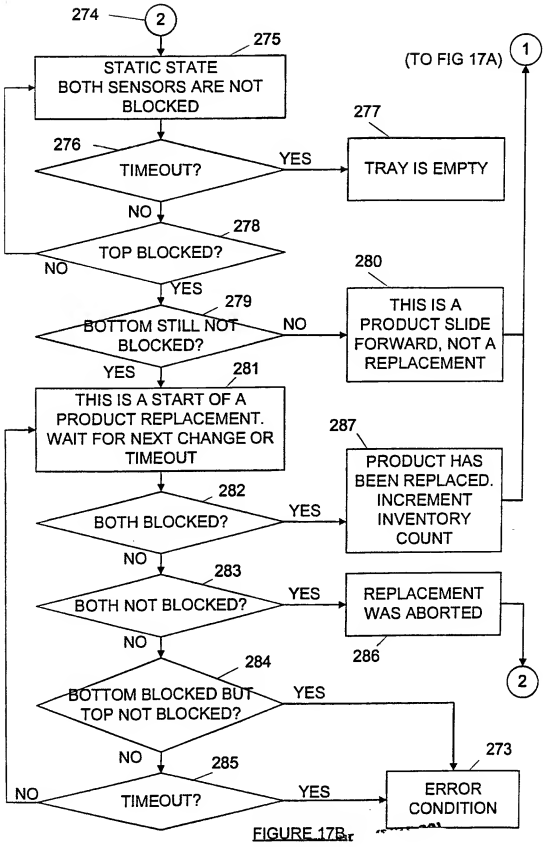
274
2
275
STATIC STATE
BOTH SENSORS ARE NOT
BLOCKED
(TO FIG 17A)
1
277
276
TIMEOUT?
YES
TRAY IS EMPTY
NO
278
TOP BLOCKED?
NO
YES
280
279
BOTTOM STILL NOT
BLOCKED?
NO
THIS IS A
PRODUCT SLIDE
FORWARD, NOT A
REPLACEMENT
YES
281
THIS IS A START OF A
PRODUCT REPLACEMENT.
WAIT FOR NEXT CHANGE OR
TIMEOUT
287
PRODUCT HAS
BEEN REPLACED.
INCREMENT
INVENTORY
COUNT
282
BOTH BLOCKED?
YES
NO
283
BOTH NOT BLOCKED?
YES
REPLACEMENT
WAS ABORTED
NO
286
284
2
BOTTOM BLOCKED BUT
TOP NOT BLOCKED?
YES
NO
273
285
NO
TIMEOUT?
YES
ERROR
CONDITION

FIGURE 17B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/02871

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B65B 35/30; G06F 15/00; B07C 5/08
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 702/128, 129, 127; 700/223; 356/73, 240; 53/443, 155, 168, 202, 237, 238, 447, 531

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

USPTO APS EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,150,307 A (MCCOURT et al) 22 September 1992 (22.09.1992), Abstract, Figs. 1-12, and cols. 2-7.	1-15
Y,P	US 5,996,316 A (KIRSCHNER) 07 December 1999 (07.12.1999), Abstract, Figs. 1-15, cols. 1-4, col. 7, lines 48-58, and col. 18, lines 35-61.	1-15

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 29 JUNE 2000	Date of mailing of the international search report 08 AUG 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer MARC HOFFE Telephone No. (703) 308-1677

Form PCT/ISA/210 (second sheet) (July 1998)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/02871

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

702/128, 129, 127; 700/223; 356/73, 240; 53/443, 155, 168, 202, 237, 238, 447, 531